

FORM PTO-1390 (Modified)  
(REV 11-2000)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

**TRANSMITTAL LETTER TO THE UNITED STATES  
DESIGNATED/ELECTED OFFICE (DO/EO/US)  
CONCERNING A FILING UNDER 35 U.S.C. 371**

**KSN0021**

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR

**09/980384**

INTERNATIONAL APPLICATION NO.

**PCT/EP00/05021**

INTERNATIONAL FILING DATE

**31 May 2000**

PRIORITY DATE CLAIMED

**31 May 1999**

TITLE OF INVENTION

**INTELLIGENT POWER MODULE**

APPLICANT(S) FOR DO/EO/US

**Michael Frisch**

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (24) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
  - a. ☐ is attached hereto (required only if not communicated by the International Bureau).
  - b. ☒ has been communicated by the International Bureau.
  - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
  - a. ☒ is attached hereto.
  - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
  - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
  - b. ☐ have been communicated by the International Bureau.
  - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
  - d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☒ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☒ A copy of the International Search Report (PCT/ISA/210).

**Items 13 to 20 below concern document(s) or information included:**

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☒ Certificate of Mailing by Express Mail
23. ☒ Other items or information:

**Return Postcard**

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 1.53) <b>09/980384</b>	INTERNATIONAL APPLICATION NO. <b>PCT/EP00/05021</b>	ATTORNEY'S DOCKET NUMBER <b>KSN0021</b>
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24. The following fees are submitted: <b>BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :</b>				<b>CALCULATIONS PTO USE ONLY</b>	
<input type="checkbox"/>	Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO .....	<b>\$1040.00</b>			
<input checked="" type="checkbox"/>	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO .....	<b>\$890.00</b>			
<input type="checkbox"/>	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO .....	<b>\$740.00</b>			
<input type="checkbox"/>	International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) .....	<b>\$710.00</b>			
<input type="checkbox"/>	International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) .....	<b>\$100.00</b>			
<b>ENTER APPROPRIATE BASIC FEE AMOUNT =</b>			<b>\$890.00</b>		
Surcharge of <b>\$130.00</b> for furnishing the oath or declaration later than months from the earliest claimed priority date (37 CFR 1.492 (e)). <input type="checkbox"/> 20 <input type="checkbox"/> 30			<b>\$0.00</b>		
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	- 20 =	0	x \$18.00	<b>\$0.00</b>	
Independent claims	- 3 =	0	x \$84.00	<b>\$0.00</b>	
Multiple Dependent Claims (check if applicable). <input type="checkbox"/>				<b>\$0.00</b>	
<b>TOTAL OF ABOVE CALCULATIONS =</b>				<b>\$890.00</b>	
<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27). The fees indicated above are reduced by 1/2.				<b>\$0.00</b>	
<b>SUBTOTAL =</b>				<b>\$890.00</b>	
Processing fee of <b>\$130.00</b> for furnishing the English translation later than months from the earliest claimed priority date (37 CFR 1.492 (f)). <input type="checkbox"/> 20 <input type="checkbox"/> 30			+	<b>\$0.00</b>	
<b>TOTAL NATIONAL FEE =</b>				<b>\$890.00</b>	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable). <input type="checkbox"/>				<b>\$0.00</b>	
<b>TOTAL FEES ENCLOSED =</b>				<b>\$890.00</b>	
				Amount to be: refunded	\$
				charged	\$

- a. ☒ A check in the amount of **\$890.00** to cover the above fees is enclosed.
- b. ☐ Please charge my Deposit Account No. \_\_\_\_\_ in the amount of \_\_\_\_\_ to cover the above fees. A duplicate copy of this sheet is enclosed.
- c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **02-0387** A duplicate copy of this sheet is enclosed.
- d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

**NOTE:** Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Eric J. Groen  
Baker & Daniels  
205 West Jefferson Blvd., Suite 250  
South Bend, IN 46601

Telephone: (219) 234-4149  
Fax: (219) 239-1900

SIGNATURE

Eric J. Groen

NAME

32,230

REGISTRATION NUMBER

November 30, 2001

DATE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Michael Frisch )  
Filed: PCT/EP00/05021 (May 31, 2000) )  
Serial No.: )  
Title: Intelligent Power Module )  
Grp./A.U.: )  
Examiner: )  
Docket No.: KSN0021 )

Honorable Commissioner for Patents  
Washington, D.C. 20231

Sir:

**PRELIMINARY AMENDMENT**

In the above-mentioned PCT application, please accept the enclosed application under the national stage pursuant to 35 USC § 371 and amend the application as follows:

In the Specification:

In the Claims:

Please replace claims 1-6 of the application with claims 1-6 as follows:

1. An intelligent power module comprising a power part of the electronic components of which are arranged on a power substrate, and a logic part of the components of which are arranged on a circuit board having a recess in which said power part is located and electrically connected to the logic part by means of wire bonding techniques, said power substrate being mounted on a cooling plate, at least a portion of said circuit board being mounted on the cooling plate.

2. An intelligent power module according to claim 1, wherein at least a strip portion along a side of the circuit board is left free and is not mounted on said cooling plate.

3. An intelligent power module according to claim 1, wherein the cooling plate has contact pads on said side by means of which the module can be soldered directly in the slot-like opening of a system circuit board.

4. An intelligent power module according to claim 1, wherein the components of the logic part are arranged on a multilayer circuit board having a recess in which said power part is located and electrically connected to said logic part, and characterized in that the multilayer circuit board has a laminate structure of conductively coated layers whose carrier material consists of a glass fiber resin fabric each, and in that the multilayer circuit board consists of two parts connected by a thin intermediate section in which all lower layers of the multilayer circuit board are not present and only the component-side uppermost layer is present as a bendable continuation in the form of a flexible, electrical and mechanical connecting layer between said two parts.

5. An intelligent power module according to claim 4, characterized in that the flexible connecting layer is bent by 180° so that said two parts continue in bendable manner.

6. An intelligent power module according to claim 5, characterized in that the first part of the multilayer circuit board, which has the recess, as well as the second, folded up part are approximately of equal size, that said first part is mounted on a cooling plate that is larger than the power substrate area, and in that the electrical connections between said power substrate and the first part of the multilayer circuit board are established by means of wire bonding techniques.

[illegible]

Respectfully submitted,

Eric J. Groen, Reg. No. 32,230  
BAKER & DANIELS  
205 West Jefferson Blvd., Suite 250  
South Bend, IN 46601  
(219) 234-4149

2/PRTS

09/980384  
JCTO Rec'd PCT/PTC 30 NOV 2001

1/11

## Description

### 5 Intelligent Power Module

The invention relates to an intelligent power module, in particular in sandwich construction.

10 IPM (intelligent power module) structures, i.e. modules having a power part with electronic components and a logic or control part integrated in the module, are utilized presently, for example, for applications in connection with welding apparatus, power supplies and in  
15 motive power engineering. Especially in the field of asynchronous motors, frequency converter solutions are employed for speed control in increasing manner, with the power part of the module making use in particular of IGBT (insulated-gate bipolar transistor) power semicon-  
20 ductors.

In selecting the power substrate as carrier for the components of the power part, care is to be taken that on the one hand high electrical insulation and on the  
25 other hand also good heat transfer is ensured towards the usually required cooling plate. The latter is not obtained with the known circuit boards of plastics material, so that the power parts, depending on the particular application requirements, presently are mounted on  
30 relatively complex substrates, for example DCB (direct copper bonding) aluminum oxide, IMS (aluminum polyimide copper) or aluminum nitrite. On the other hand, the logic parts may easily be manufactured on the basis of the conventional epoxy circuit boards.

Problematic with the conventional modular technology is the connection between the logic part and the power part. This connection, which typically makes use of solder contacts, pluggable connections or pressure contacts, frequently is a weak point in terms of quality and causes high costs. The problems become even greater with the connecting technology if, for reasons of space, a sandwich-type construction of the module is demanded by the user in which, for example, the power substrate is connected via pins to the logic part arranged thereabove, as it is known e.g. from EP 0 463 589 A2. Such logic power modules in sandwich construction are already available in the market.

The patent specification US 4,495,546 already reveals a sandwich structure which, however, is not concerned with power modules, but with two thick film circuits having aluminum substrates which are both covered by a flexible circuit board which, moreover, forms between the two circuit parts a flexible intermediate section that is bent by 180° in order to constitute the sandwich structure. Due to the fact that not only the intermediate section to be bent, but the circuit board in its entirety is flexible, polyimide - which is known as material for flexible circuit boards - is suggested, which however is relatively expensive.

The document WO96/13966 discloses a module comprising power and logic components that are integrated on a substrate. The power semiconductors are electrically connected to the substrate by thick wire. The substrate is then integrated in a system circuit board and connected thereto by means of soldered terminal pins. The terminal pins are capable of compensating the differing thermal expansion of substrate and circuit board. A disadvantage consists in that all components of the module are mounted on the expensive power substrate and that the

connection of the module to the system circuit board is very complex.

It is an object of the invention to make available an  
75 intelligent power module, in particular in sandwich construction, which does not require expensive connecting techniques and thus can be manufactured easily.

According to the invention, this is achieved by an intelligent power module comprising the features indicated  
80 in claim 1.

The power module consists of a power part whose electronic components are arranged on a power substrate, and  
85 of a logic part whose components are arranged on a circuit board or multilayer circuit board. The separation of logic components and power components provides the advantage that an inexpensive circuit board can be used for the logic part and that only a small, expensive,  
90 powerful power substrate is necessary.

The circuit board has a recess in which the power substrate is located and electrically connected to the logic part. This connection by means of thick AL wire  
95 can be established inexpensively in integral manner.

The power substrate itself as well as the portions of the circuit board surrounding the power substrate are mounted on a cooling plate.  
100

In a first embodiment of the invention, however, at least a strip portion is left free along a side of the circuit board. The circuit board has contact pads on this side, by means of which the module can be soldered  
105 directly in the slot-like opening of a system circuit board. In a second embodiment, the circuit board is in the form of a multilayer board having a laminate con-



struction of conductively coated layers whose carrier material consists of a glass fiber resin fabric each.  
110 The multilayer circuit board consists of two parts that are connected by a thin intermediate section in which all lower layers of the multilayer circuit board are not present and the uppermost layer on the side of the components is a bendable continuation in the form of a  
115 flexible electrical and mechanical connecting layer between the two parts.

Advantageous developments of the invention are subject matter of dependent claims.

120

The invention will be elucidated in more detail hereinafter by way of an embodiment with reference to the drawing figures in which

125 Fig. 1 shows a perspective plan view of a first embodiment of a module according to the invention in the state in which the same is not yet soldered into a system circuit board;

130 Fig. 2 shows a sectional side view of the same module as in Fig. 1, however in the finished, soldered state;

135 Fig. 3 shows a perspective plan view of a second embodiment of a module according to the invention in the state in which the same is not yet folded together;

140 Fig. 4 shows a sectional side view of the same module as in Fig. 3, however in the finished, folded state.

Fig. 1 shows a module which, for example, is suitable for power losses as of 20 W and basically consists of a logic part and a power part. The components 1 of the power part, which mainly comprise power semiconductors, are arranged on a suitable (cf. above) power substrate 2, and in particular are bonded thereto. The components 3 and 4 (ICs and other SMD components) of the logic part are arranged on a circuit board 5 of conventional material, which has a recess 6 of the size of the power part. The power substrate 2 arranged in the recess 6 is connected by bonding wires 7 to the surrounding portions of the circuit board 5. A complex connecting technique, e.g. by means of contact combs, thus is avoided at this location. The circuit board that is interrupted initially by the individual recesses only thus can be bonded in integral manner.

The major part of the circuit board 5, together with the power substrate 2 arranged therein, is mounted on a cooling plate 8, for example by means of thermally conductive adhesive or by soldering techniques. The top side of this major part of the circuit board 5 may be covered e.g. by a silicone casting compound 10 for protection of the semiconductor components. Anyway, the strip portion 9 left free from the casting compound 10 and the cooling plate 8, respectively, must be sufficiently wide to permit the formation of contact pads 11 on the circuit board 5 proper as well as the insertion thereof through the opening slot 12 of a second circuit board, in the instant case a system circuit board 13.

Fig. 2 shows a flow-soldered module with soldering points 14. Such directly solderable circuit boards indeed have become known recently, but they are not employed in the functional unit of power modules, which typically make use of sturdier constructional elements.



are connected there by a thin connecting layer 109 only.  
220 This ensures on the one hand a direct electrical connection between the two parts 107 and 108 without additional connecting technique, whereas on the other hand the mechanical connection between the two parts 107 and 109 is no longer rigid, but flexible. In terms of manufacturing technology, this may be achieved, for example,  
225 in that gaps (for the intermediate sections) are integrally stamped such that the multilayer circuit board parts 107 and 108 are connected on webs only. Thereafter, a last, uppermost layer is laminated over the two  
230 parts 107 and 108 and over the gap stamped before, with this layer then constituting the intermediate section in the form of a flexible connecting layer 109. This is followed by breaking out of the individual, two-part multilayer circuit boards, mounting of the cooling  
235 plates and loading with logic components or insertion of the power substrate into the recess 110 provided.

As regards the carrier material for the layers and thus also for the uppermost connecting layer 109, e.g. conventional copper-coated glass fiber resin fabric with  
240 the specification (NEMA grade) FR4 and FR5 is suitable. The glass fiber-like connecting layer 109 with a thickness of approx. 0.3 mm is stable and flexible enough for bending thereof, e.g. about 90 or 180°.

245 Fig. 4 illustrates a finished sandwich structure of the module according to the invention. This illustration reveals the superimposed parts 107 and 108 of the multilayer circuit board which are approximately of equal  
250 size and loaded with SMD components 103 to 105, e.g. ICs or passive components or with pluggably mounted components 106. The first part 107 of the multilayer circuit board, along with the power substrate 102 arranged therein, is mounted on a cooling plate 111, for example  
255 by means of thermally conductive adhesive or by solder-

ing techniques. The connection between the power substrate 102 and the first part 107 by wire bonding techniques 112 is visible as well. By continuation of the component-side uppermost layer of part 107, i.e. of the  
260 connecting layer 109, the two rigid parts 107 and 108 may be folded about the flexible intermediate piece.

The module may be installed in a housing in particular by way of its cooling plate 111, and in this respect the  
265 upper part 108 advantageously may be mechanically locked to the housing as well. The upper part 108 is usually provided with terminals constituting the mains terminals of the module as well as the terminals to the unit driven or controlled. The module may also be connected  
270 in addition to a system circuit board.

## Translation of Annex to the IPER

## 5 Claims

1. An intelligent power module comprising  
a power part the electronic components (1) of which  
are arranged on a power substrate (2), and  
a logic part the components (3, 4) of which are ar-  
ranged on a circuit board (5) having a recess (6) in  
which said power part is located and electrically  
connected to the logic part by means of wire bonding  
techniques (7),  
said power substrate (2) being mounted on a cooling  
plate (8),  
characterized in that said circuit board is mounted  
on the cooling plate in part only, namely only with  
portions of the circuit board surrounding the power  
substrate (2).
2. An intelligent power module according to claim 1,  
characterized in that at least a strip portion (9,  
109) along a side of the circuit board (5) is left  
free and is not mounted on said cooling plate.
3. An intelligent power module according to claim 2,  
characterized in that the cooling plate (5) has con-  
tact pads (11) on said side by means of which the  
module can be soldered directly in the slot-like  
opening (12) of a system circuit board (13).
4. An intelligent power module according to claim 1,  
characterized in that the components (103, 104, 105,  
106) of the logic part are arranged on a multilayer

circuit board (107, 108) having a recess (110) in which said power part is located and electrically connected to said logic part, and characterized in that the multilayer circuit board (107, 108) has a laminate structure of conductively coated layers whose carrier material consists of a glass fiber resin fabric each, and in that the multilayer circuit board consists of two parts (107, 108) connected by a thin intermediate section in which all lower layers of the multilayer circuit board (107, 108) are not present and only the component-side uppermost layer is present as a bendable continuation in the form of a flexible, electrical and mechanical connecting layer (109) between said two parts (107, 108).

5. An intelligent power module according to claim 4, characterized in that the flexible connecting layer (109) is bent by 180° so that said two parts (107, 108) continue in bendable manner.
6. An intelligent power module according to claim 5, characterized in that the first part (107) of the multilayer circuit board, which has the recess (110), as well as the second, folded up part (108) are approximately of equal size, that said first part (107) is mounted on a cooling plate (111) that is larger than the power substrate area, and in that the electrical connections (112) between said power substrate (102) and the first part (107) of the multilayer circuit board are established by means of wire bonding techniques (112).

335    **Abstract**

The power part and the logic part of the module are arranged on different substrates. The circuit board (5) of the logic part has a recess (6) in which the power substrate (2) is located and electrically connected to the  
340    logic part by wire bonding techniques (7).



FIG 1

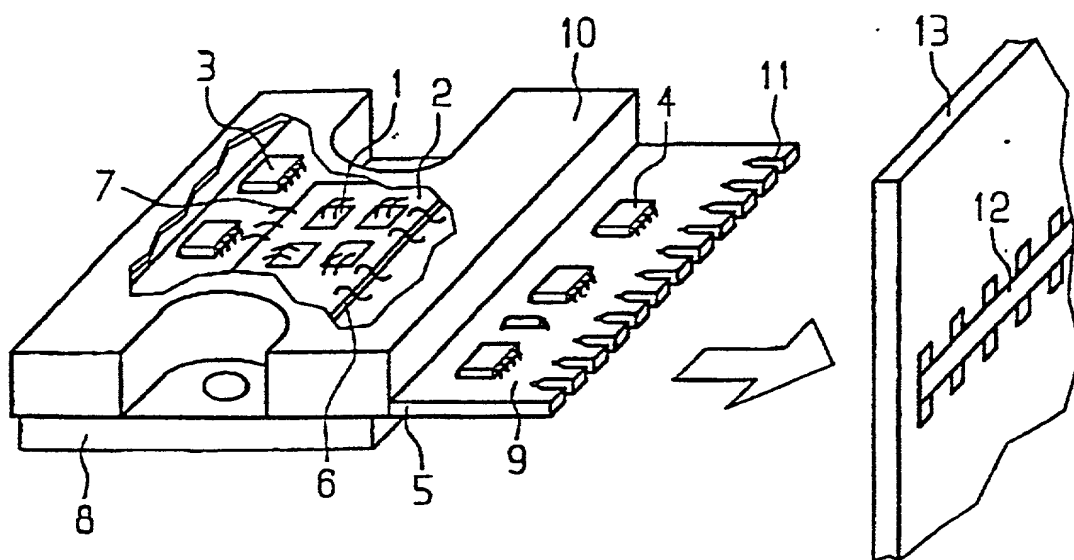


FIG 2

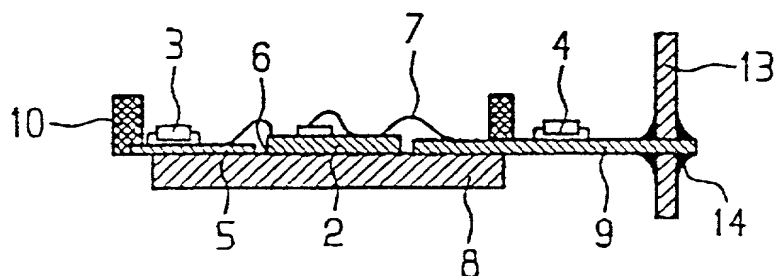


FIG 3

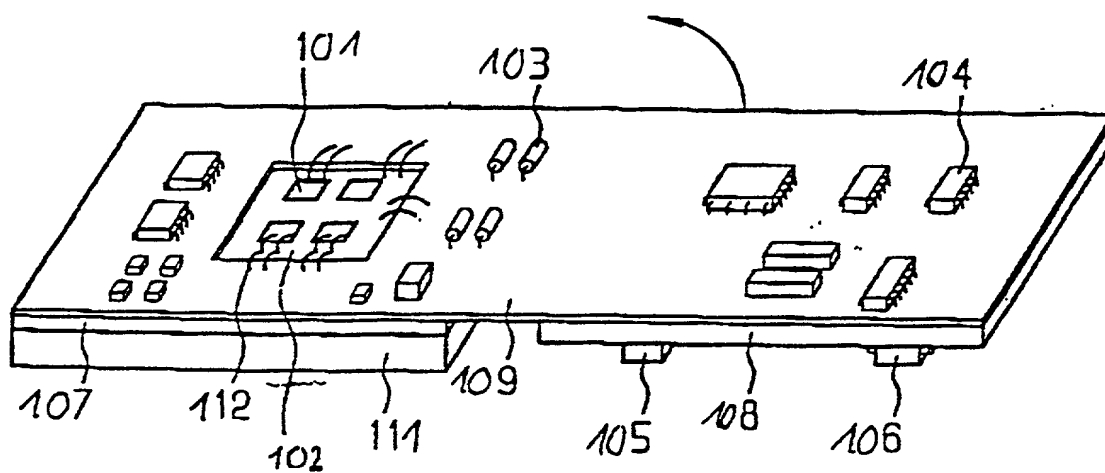
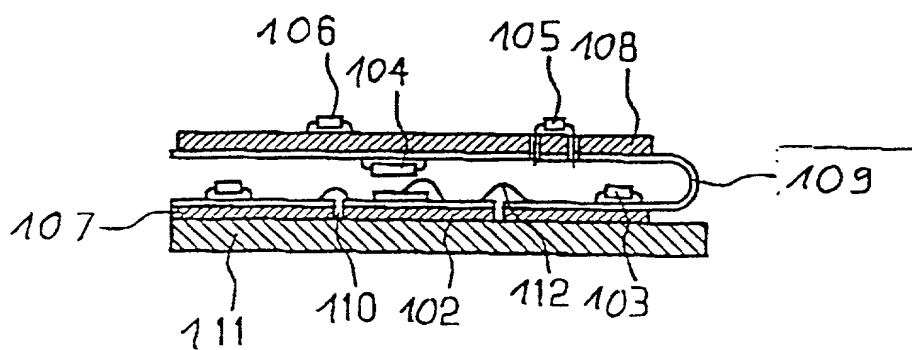


FIG 4



Total additional fees required for this application is **\$130** for a Large Entity:

- **\$130** Late oath or declaration Surcharge.

Applicant is reminded that any communications to the United States Patent and Trademark Office must be mailed to the address given in the heading and include the U.S. application no. shown above (37 CFR 1.5)

*A copy of this notice **MUST** be returned with the response.*

SHELBY J VIGIL

Telephone (703) 305-3653

PART 1 - ATTORNEY/APPLICANT COPY

U.S. APPLICATION NUMBER NO	INTERNATIONAL APPLICATION NO	ATTY DOCKET NO
09/980,384	PCT/EP00/05021	KSN0021

FORM PCT/DO/EO/905 (371 Formalities Notice)

05/02/2008 MAIL: 0010001 101010

02 FC4154

12 11 07



I hereby claim the benefit under 35 U.S.C. Section 119(e) of any United States provisional application(s) listed below:

\_\_\_\_\_  
(Application Serial No.)

\_\_\_\_\_  
(Filing Date)

\_\_\_\_\_  
(Application Serial No.)

\_\_\_\_\_  
(Filing Date)

\_\_\_\_\_  
(Application Serial No.)

\_\_\_\_\_  
(Filing Date)

I hereby claim the benefit under 35 U. S. C. Section 120 of any United States application(s), or Section 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. Section 112, I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, C. F. R., Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

**PCT/EP00/05021**

**31 May 2000**

**Pending**

\_\_\_\_\_  
(Application Serial No.)

\_\_\_\_\_  
(Filing Date)

\_\_\_\_\_  
(Status)  
(patented, pending, abandoned)

\_\_\_\_\_  
(Application Serial No.)

\_\_\_\_\_  
(Filing Date)

\_\_\_\_\_  
(Status)  
(patented, pending, abandoned)

\_\_\_\_\_  
(Application Serial No.)

\_\_\_\_\_  
(Filing Date)

\_\_\_\_\_  
(Status)  
(patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. *(list name and registration number)*

Eric J. Groen, ~~32,230~~

Gerard T. Gallagher, ~~39,679~~

Daniel Tychonievich, ~~41,358~~

Kevin R. Erdman, ~~33,687~~

John F. Hoffman, ~~26,280~~

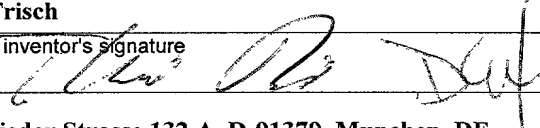
Anthony Niewyk, ~~24,871~~

Nancy G. Tinsley, ~~37,098~~

Arthur R. Whale, ~~18,778~~

Send Correspondence to: Eric J. Groen  
Baker & Daniels  
205 West Jefferson Blvd., Suite 250  
South Bend, IN 46601

Direct Telephone Calls to: *(name and telephone number)*  
 Eric J. Groen (219)234-4149

Full name of sole or first inventor <b>Michael Frisch</b>	
Sole or first inventor's signature 	Date <b>2. Apr 2002</b>
Residence <b>Boschetsrieder Strasse 132 A, D-91379, Munchen, DE</b>	
Citizenship <b>German</b>	
Post Office Address <b>Boschetsrieder Strasse 132 A, D-91379, Munchen, DE</b>	

Full name of second inventor, if any	
Second inventor's signature	Date
Residence	
Citizenship	
Post Office Address	